“TO COMPARE DIFFERENT RESPIRATORY PATTERNS ON UPPER LIMB EXERCISE CAPACITY IN PATIENTS WITH COPD”

A Dissertation Submitted to

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY

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9/1 KEERANATHAM ROAD,

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Under the guidance of

Prof.KS.RAJA SHENTHIL M.P.T (Cardio-Resp)., MIAP.,(PhD).,

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Dissertation Evaluated on ____________________________

Internal Examiner **External Examiner**

CERTIFICATE

This is to certify that the dissertation entitiled **"TO COMPARE DIFFERENT RESPIRATORY PATTERNS ON UPPER LIMB EXERCISE CAPACITY IN PATIENTS WITH COPD"**is a bonafide compiled work, carried out by **Register No: 271530207,** PPG College of Physiotherapy,Coimbatore-641035 in partial fulfillment for the award of degree in Master of Physiotherapy as per the doctrines of requirements for the degree from **THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY, CHENNAI-32.** This work was guided and supervised by **Prof. KS.RAJA SHENTHIL M.P.T (Cardio-Resp).,MIAP.,(PhD).,**

DATE: **PRINCIPAL**

PLACE:

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First I would like to thank the **Lord Almighty** and **My Parents**, **My Brothers and Friends** for their unfailing love, affection and endless blessings.

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LIST OF ABBREVIATIONS USED

ADL: Activities of Daily Living

ATP: Arm Training Program

CAP: Control Arm Position

COPD: Chronic obstructive Pulmonary Disease

DALY: Disability Adjusted Life Years

EELV: End-Expiratory Lung Volume

FFM: Fat free mass

GOLD: Global initiative for chronic Obstructive Lung Disease

HRQOL: Health Related Quality of Life

IC: Inspiratory Capacity

SAE: Supported Arm Elevation

SD: Standard Deviation

SGRQ: St. George Respiratory Questionnaire

Spo_2: Oxygen saturation

SULEX : Supported Upper Limb Exercise test

UL : Upper Limb

UUEET : Unsupported Upper Extremity Exercise Training

UULEX : Unsupported Upper Limb Exercise test

ABSTRACT

Objectives: To compare different respiratory patterns on upper limb exercise capacity in patients with COPD.

Methods: Twenty two COPD patients were recruited in the study from various hospital and old age homes across Mangalore. Upper limb exercise capacity was measured in all four types of exercises two shoulder flexion-extension (one associated with inspiratory time during the concentric phase and the other associated with expiratory time) and two shoulder abduction-adduction (same timing as above). Borg's score and heart rate was noted pre and post UL exercise testing, Recovery both subjective and objective was noted post exercise testing Statistical analysis was done using Shapiro wilk test, independent t-test. Wilcoxon signed Ranked t-test, and Friedman test.

Results: The patient with COPD were able to perform better for longer duration with inverted breathing pattern (expiration during concentric phase of UL movement involving exercise 2 and exercise 4) when compared with the results of exercise frequently applied in clinical practice (inspiration during concentric phase of UL movement involving exercise 1 and exercise 3). There was significant difference in duration for which exercise test was performed between exercise 1 and exercise 2 with p-value of 0.002, between exercise 3 and exercise 4 with p-value <0.001. In addition among the studied exercises, exercise 4 shows significant increase in Spo2 post exercises (p-value < 0,001) with prolonged recovery 2 (objective) period for the same exercise suggesting that the gain in Spo2 was maintained for longer time as compare to other exercise.

Conclusion: The exercises performed with inverted respiratory time (exercise 2 and exercise 4) were able to perform better than other exercise (exercise 1 and exercise 3) and can be used as important strategies during physical exercise programs in these patients.

Keywords: COPD, Respiratory exercise pattern (breathing exercise), Physiotherapy, Upper limb exercise capacity.

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Dedicated to my family, my teachers and all COPD patients

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a common preventable and treatable disease which is characterized by persistent airflow limitation that is usually and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles and gases. Exacerbations and co-morbidities contribute to the overall severity in individual patients. [(1)]

The chronic airflow limitation characteristic of COPD is caused by a mixture of small airway disease (obstructive bronchiolitis) and parenchymal destruction (emphysema), the relative contributions of which vary from person to person. Chronic inflammation causes structural changes and narrowing of the small airways. Destruction of lung parenchyma, also by inflammatory process, leads to the loss of alveolar attachments to the small airways and decrease lung elastic recoil; in turn, these changes diminish the ability of the airway to remain open during expiration. [(1)]

Globally, COPD has emerged as the major cause of morbidity and mortality expected to become the 3" most leading cause of death and leading cause of loss of "Disability Adjusted Life Years as per projection of the global burden of disease study. [(1)]

COPD is a global health issue, with cigarette smoking being an important risk factor universally; other factors, such as exposure to indoor and outdoor air pollution. occupational hazards, infections, gender, genetic factors (deficiency of the serine protease al antitrypsin), ageing, asthma, and socio-economic status. [(3)]

Tobacco smoking is the main risk factor for COPD, although other inhaled noxious particles and gases may contribute. This causes an inflammatory response in the lung, which is exaggerated in some smokers, and leads to the characteristic pathological lesions of COPD. In addition to inflammation, an imbalance of proteinases and anti proteinases in the lungs, and oxidative stress are also important in the pathogenesis of COPD. [4]

According to the GOLD (Global Initiative for Chronic Obstructive Lung Disease) guidelines, a diagnosis of COPD can be established by a fixed ratio of post bronchodilator FEV_1 and FVC below 0.7 measured by spirometer (3) The spirometric severity is graded according to the percentage o FEV_1 predicted (GOLD stage I-IV). This functional definition, based on airflow limitation, has been used to characterize the disease until now, but, obviously, the degree of airflow limitation is only one aspect in the risk assessment of patients with COPD. [5]

Spirometric general Classification of COPD :

Severity	Post bronchodilator FEV1/FCV	FEV1% predicted
At risk Patients who: • smoke or have exposure to pollutants • have cough, sputum or dyspnea • have family history of respiratory disease	>0.7	≥80
Mild COPD	≤0.7	≥80
Moderate COPD	≤0.7	50-80
Severe COPD	≤0.7	30-50
Very severs COPD	≤0.7	<30

FEV1: Forced Expiratory Volume in one second; FVC: Forced Vital Capacity.[4.5]

The clinical severity of COPD is increasingly being recognized as being determined by concomitant co-morbidities apart from COPD specific features (i.e., hyperinflation and/or the presence of emphysema). [6,7]

Airflow obstruction has profound effects on cardiac function and gas exchange with systemic consequences. In addition, as COPD results from inflammation and/or alterations in repair mechanisms, the "spill-over" of inflammatory mediators into the circulation may result in important systemic manifestations of the disease, such as skeletal muscle wasting and cachexia.[8]

Systemic inflammation may also initiate or worsen comorbid diseases, such as ischemic heart disease, heart failure, osteoporosis, normocytic anemia, lung cancer, depression, endocrinological disturbances like diabetes and changes in body composition. [8,9]

Involuntary weight loss as a result of an abnormal loss of FFM which is a reflection of the metabolically active organs of which skeletal muscle is the largest, are related to typical symptoms of patients with COPD like exercise intolerance, muscle weakness and impaired disease-specific health status. Reduced body weight had an independent negative effect on muscle aerobic capacity in COPD patients. [9]

Reduced capacity to perform physical exercise is a common manifestation in coPD, with patients presenting limitation in physical activities requiring normal exertion "10 and lower levels of physical activity when compared with healthy controls. [11]

Patients with COPD have reduced arm exercise capacity and frequently experienced marked dyspnea and fatigue during the performance of arm tasks important for daily living. [12]

Ventilatory factors underlie the limitation to arm exercise in people with COPD. During arm exercise, the accessory muscles of respiration are required for the arm task and may not be able to contribute to breathing. [13] In addition, since the muscles that move the arms and stabilize the trunk are attached to the rib cage, this increases chest wall impedance, which limits the ability to increase tidal volume during arm activities. [12,14]

There is a resultant shift in the respiratory load to mechanically disadvantaged diaphragm, which results thoraco-abdominal dyssynchrony and triggers the premature appearance of dyspnea and fatigue, causing reduction of upper limbs endurance capacity in these patients. [12,15]

Upper limb exercises are frequently used in respiratory physiotherapy, with upper limb elevation and controlled inspiratory time. Dirceu Costa et al. have investigated the respiratory pattern of COPD patients during different upper limb exercises associated with respiratory exercise. They concluded that exercises performed with inverted respiratory time produced less thoraco-abdominal asynchrony and can be used as important strategies during physical exercise programs in these patients. [16]

Still there are inconcrete evidences and lack of literatures on the influence of different respiratory patterns in patients with COPD. Hence, this study is intended to focus on the different respiratory patterns on upper limb exercise capacity in COPD patients.

AIMS AND OBJECTIVES OF THE STUDY

- ## AIM :

1. To compare different respiratory patterns on upper limb exercise capacity in patients with COPD

- ## OBJECTIVES :

1. To compare the influence of different respiratory patterns on duration of upper limb exercise test in patients with COPD.
2. To compare the influence of different respiratory patterns on oxygen saturation with upper limb exercise test in patients with COPD.
3. To compare the influence of different respiratory patterns on rate of perceived exertion with upper limb exercise test in patients with COPD.
4. To compare the influence of different respiratory patterns on heart rate with upper limb exercise test in patients with COPD.
5. To compare the influence of different respiratory patterns on recovery period (both subjective and objective recovery) post upper limb exercise test in patients with COPD.

REVIEW OF LITERATURE

1.Sundeep Salvi and Anurag Agrawal (2015)

stated that COPD kills more than 3 million people every year, making it the 4th largest cause of death in the world They estimated that there are over 30 million COPD sufferers in India. They have stated the fact that mortality rates due to COPD are anticipated to increase by over 160% over the next 2 decades and half a million people die every year due to COPD in India, which is over 4 times the number of people who die due to COPD in USA and Europe. They have estimated that by the year 2030. COPD will become the third biggest cause of death. [17]

2. Arvind Bhome (2014)

reviewed about COPD in India with emphasis on understanding the multi-dimensional nature of the problem and an attempt of providing insight into possible de-bottlenecking to reduce the pain and suffering of millions of COPD patients in India in future. He stated that India contributes very significantly to mortality from COPD 102.3/100,000 and 6,740,000 DALYs out of world total of 27,756,000 DALYs; thus significantly affecting Health related Quality of Life in the country. [18]

3**. James C Hogg and Wim Time (2013)**

have stated that pathogenesis of COPD is based on the innate and adaptive inflammatory immune response to the inhalation of toxic particles and gases. They stated that although tobacco smoking is the primary cause of inhalation injury, many other environmental and occupational exposures contribute to the pathology of COPD. They also stated that the immune inflammatory changes associated with COPD are linked to a tissue-repair and remodeling process that increases mucus production and causes emphysematous destruction of the gas-exchanging surface of the lung. [19]

4. Victor Zuniga Durado et al. (2011)

conducted a review with an aim to discuss findings in the literature related to the systemic manifestations of copro emphasizing the role played by systemic inflammation and evaluating various therapeutic strategies. They stated the likely mechanisms involved in the process of local and systemic inflammation in this disease which include an increase in the number of inflammatory cells (resulting in abnormal production of inflammatory cytokines) and an imbalance between the formation of reactive oxygen species and antioxidant capacity (leading to oxidative stress). They concluded that both local manifestations (dyspnea and deconditioning) and systemic manifestation (anorexia and peripheral muscular dysfunction) leads to decrease exercise tolerance which in turn leads to decrease quality of life in COPD patients. [20]

5. Yvonne Nussbaumer-Ochsner and Klaus F. Rabe (2011)

have discussed about extra-pulmonary co-morbidities which significantly complicates the management and influences the prognosis of patients with COPD. They have stated that certain co-morbidities like cardiovascular diseases share some risk factors with COPD, such as cigarette smoking and other frequently observed co-morbidities which include musculoskeletal wasting, metabolic syndrome, and depression cannot be easily attributed to smoking. They have concluded that the treatment of COPD is no longer focused exclusively on inhaled therapy but has taken on a multidimensional approach, especially because the treatment of the co- morbidities may positively affect the course of COPD itself. [21]

6. Nicolas Roche et al. (2013)

has described characteristic symptoms of COPD which includes progressive dyspnea, cough and sputum production as they have a considerable impact on patient's lives, in particular on those patients with severe COPD. They stated that breathlessness, which is a consequence of the characteristic lung hyperinflation seen in COPD, is one of the most frequently reported symptoms and significantly limits exercise capacity. They concluded that COPD symptoms in the morning are strongly associated with problems experienced by patients in performing simple morning activities, resulting in a noticeable impact on patients' quality of life. [22]

7. Toru Oga et al. (2003)

conducted a study to analyze the relationships of exercise capacity and health status to mortality in patients with COPD. They enrolled l44 COPD patients who were available for the 5-year follow-up, 31 had died during course of study. Univariate Cox proportional hazards analysis revealed that the SGRO total score and the Breathing Problems Questionnaire were significantly correlated with mortality. Multivariate Cox proportional hazards analysis revealed that the peak oxygen uptake and the SGRQ total score were both predictive of mortality, independent o FEVI and age. Stepwise Cox proportional hazards analysis revealed that the peak oxygen uptake was the most significant predictor of mortality. They concluded that exercise capacity and health status were significantly correlated with mortality. [23]

8.Thomas E. Dolmage et al. (1993)

have studied the ventilatory response to arm elevation using a customized arm support sling to eliminate the effect of an increase in metabolic activity that might be attributable to independent arm elevation and used leg exercise to increase metabolic activity. They found that when supported arm elevation (SAE) was compared with the control arm position minute ventilation was unchanged although the pattern of breathing (CAP), became more rapid and shallow. They suggested that training programs should be coupled with strategies that either support the arms during activity or allow frequent rests during which the arms are lowered. They further suggested that incorporating specific training and strategies for arm elevation activities may result in a reduction in dyspnea and an increase in the quality of life of patients with COPD greater than that achieved by general fitness programs alone. [(24)]

9. Zoe J McKeough et al. (2003)

conducted a study to evaluate the effect of different arm positions on static lung volumes in COPD and healthy subjects using a plethysmography. They found that lung volumes were altered in COPD subjects and healthy subject when comparing the arm positioned above 90 degrees shoulder flexion with arms at or below 90 degrees of shoulder flexion. In the COPD subjects, breathing at higher lung volume, and having reduced capacity to have a deep breath when the arms were above the head, may influence the ability to perform everyday arm tasks that require elevation of arms above the head. They suggested that modification of arm tasks so that arms are only elevated to 90 degrees may assist in making arm work more achievable for subjects with COPD

10.E.F.Porto et al. (2009)

conducted a study of assess pulmonary hyperinflation and ventilatory parameters in patients with COPD after performing an exercise using the upper limbs and compare them in the same patients after walking on a treadmill using the same metabolic load, in order to evaluate the influence of the ventilatory pattern on the dynamics of pulmonary hyperinflation. They concluded that a substantial number of COPD patients, when performing movements with upper limbs, similar to the ones often used in daily activities, may hyperinflate Hyperinflation generated by an exercise using the upper limbs is more severe than that generated by lower limbs exercises when performed a the same metabolic load due to shallow breathing. [26]

11. Marcelo Colucci et al. (2010)

conducted a study with to evaluate the development of dynamic hyperinflation during upper limb exercise in arm cycloergo meter with workloads equivalent to 50% 65%, and 80% of maxima incremental test in severe COPD patients. They concluded that higher workloads during a set of upper limb exercise in patients with severe and very severe COPD directly influence the reduction of the inspiratory capacity (IC), causing dynamic pulmonary hyperinflation. Dynamic pulmonary hyperinflation is directly related to a less efficient performance during the exercises and to a reduction in the endurance time. [27]

12.J. Ucer C. (2004)

has conducted study to determine the effects of 12. Cemy um work on breathing pattern during a well-controlled work task. They have measure the depth of breathing, breathing frequency and end-expiratory lung volume (EELV) at rest and during cycling exercise using an arm and a leg ergometer. They found that arm work places increased demand on ventilatory system including muscles of respiration that are also recruited for task performance. They concluded that the competition for using these muscles for breathing as opposed to a particular work task may result in a compromise in breathing capacity that ultimately may limit the ability to perform tasks requiring sustained heavy use of the arms. [28]

13. Stefania Costi et al. (2009)

have studied the effects of 15 sessions of unsupported upper extremity exercise training (UUEET) on functional exercise capacity, the ability to improve activities of daily living (ADL) and symptoms perceived during activities involving arms in patients with COPD. The study provided new and relevant data regarding benefits of UUEET on ability to perform ADL involving UL and fatigue related to these activities. They found that benefits demonstrated in exercise capacity and dyspnea during daily activities were still sustained after 6 months in those who received upper extremity exercise training in addition to normal pulmonary rehabilitation. (29)

14. Tania Janaudis-Ferreira et al. (2011)

conducted study to evaluate the effect of upper extremity resistance training for patients with COPD on dyspnea during activity of daily living (ADL), arm function, arm exercise capacity, muscle strength, and health-related quality of life (HROL) They concluded that resistance-based arm training program (ATP) improved arm function, arm exercise capacity, and muscle strength in patients with coPD. They found out no improvements in dyspnea during ADL and HRQL, patients achieved a superior performance during tests of arm exercise capacity, without any increase in the symptoms of dyspnea or arm fatigue after training, witch reflects a positive effect on the patients' functional status. Their results highlighted the benefits of arm exercise training as part of COPD rehabilitation, as it is effective, feasible, and safe, and improves arm function without an increase in symptoms. (30)

15. Tetsuya Takahashi et al. (2003)

developed a new unsupported upper limb exercise test to measure upper limb exercise capacity for patients with COPD They conducted study with an objective to examine the within patient reproducibility of unsupported upper limb exercise test (UULEX) and to compare the UULEX and a supported upper limb exercise test (SULEX) in patients with COPD. They found that new unsupported upper limb exercise testing is a reproducible and acceptable exercise test that can be used as a simple method to evaluate upper limb function in COPD patients.[31]

16. Dirceu Costa et al. (2011)

have conducted a study to investigate the respiratory pattern of COPD patients during different upper limb exercises associated with respiratory exercises. Respiratory pattern was analyzed using inductance plethysmography during four types of upper limb exercise, two shoulder flexion-extention (one associated with inspiratory time during concentric phase and other associated with expiratory time) and two shoulder abduction and adduction(same timing as above). They found that exercises performed with inverted respiratory time produced less thoraco-abdominal asynchrony. They suggested that inverted respiratory patterns can be used as important strategies during physical exercise program in COPD patients. [16]

METHODOLOGY

STUDY DESIGN

- Cross sectional study.

INCLUSION CRITERIA:

- Stable diagnosed cases of COPD patients
- Receiving pulmonary drugs
- Smokers or former smokers

EXCLUSION CRITERIA

- Age above 80 years
- Any musculoskeletal disorder that interferes performance
- Uncontrolled arterial hypertension
- Significant cardiovascular disorder
- History of cerebrovascular accident
- Clinically unstable condition

TOOLS USED FOR THE STUDY

- Pulse oximeter
- Metronome
- Stop watch
- Borg’s scale (6-20)

POPULATION AND SAMPLE

The study was carried out in various hospital and old age homes in coimbatore. Twenty two patients suffering from COPD were recruited. The patients were screened for inclusion and exclusion criteria and those who fulfill the criteria were included for the study.

This study was approved by the institute ethical committee of PPG college of physiotherapy.

SAMPLING: Convenient Sampling

DATA COLLECTION

Voluntary participation for the study was considered. An informed consent was obtained from each participant. Consent from hospital and old age homes authorities was obtained after explaining the objectives as well as method of the study.

Data were collected from the month of August 2013 January 2014.

The demographic data were obtained initially and it includes variables like name, age, sex, height, weight. BMI, smoking status, stage of COPD. oxygen saturation and phone numbers were noted.

The subjects were taught any one of the exercise (randomly selected one out of 4 exercises) (learning phase). After 10 minutes of rest period, upper limb exercise testing was performed by using randomly selected one out of 4 exercises mentioned in the task (exercise test phase).

Rate of perceived exertion using Borg's scale (6-20) and oxygen saturation using pulse oximetry were measured, before and after the exercise test phase.

Metronome was used to maintain the pace of exercise test. The pace was set at 20 beats per min and on each beat patient completed one full cycle of respiration along with the upper limb task.

The duration for which the exercise tests were performed was recorded using a stopwatch.

Exercise testing was terminated when

i. Patient was unable to maintain pace with metronome

ii. Had a sense of fatigue or discomfort

iii. Oxygen saturation falls below 88%.[32]

A washout period of 48 hours was given between each exercise test.

TASK

1st Exercise: subjects were asked to perform shoulder flexion from 180° to 0° (upper limbs elevation) with inspiration, and return to the initial position with expiration (shoulder extension: 180° to 0°).

2nd Exercise: subjects were asked to perform shoulder flexion from 0° to 180° (upper limbs elevation) with expiration, and return to the initial position with inspiration (shoulder extension: 180° to 0°).

3rd Exercise: subjects were asked to perform shoulder horizontal abduction (initial position: shoulder flexion at 90) with inspiration, and return to the initial position with expiration (shoulder horizontal adduction)

4th Exercise: subjects were asked to perform shoulder horizontal abduction (initial position: shoulder flexion at 90^o with expiration, and return to the initial position with inspiration (shoulder horizontal adduction)

DATA PROCESSING AND STATISTICAL ANALYSIS

Data were coded according to coding scheme and a master chart was prepared for further statistical analysis. Data were analyzed using IBM SPSS 20.0.

Descriptive statistics, Independent t-test. Wilcoxon signed ranked t test and Friedman test were used for analysis of data.

1. ARITHMETIC MEAN
2. STANDARD DEVIATION (S D)

RESULTS

Normality of collected data was established by Shapiro-Wilk test as sample size was less than 50. Here the outcome data did not followed the normal distribution therefore non parametric test of significance was used. While the demographic data followed normal distribution therefore expressed in mean and standard deviation (SD). Wilcoxon signed ranked t-test was used to analyze significant difference within pre and post exercise testing for SpO_2. Borg's score, heart rate and also for difference within recovery 1 (subjective) and recovery 2 (objective). Friedman test was used to analyze significant difference between all four UL exercise tests.

TABLE : 5.1: Demographic characteristics of the patients

CHARACTERISTIC	**N = 22**
Age, mean (SD), Years	67.5(5.6)
Height, mean (SD), cm	162.3(6.9)
Weight, mean (SD), kg	62.4(7.7)
BMI, mean (SD),kg/ms	23.9(2.9)
Moderate COPD (n)	12
Severe COPD (n)	10

TABLE : 5.2: Gender distribution of the subjects

PARAMETER	MALE	FEMALE	p-value
N	9	13	
Age, mean (SD), year	68.7 (3.7)	6.7 (6.6)	0.40
Height, mean (SD), cm	163.8 (7.2)	161.3 (6.7)	0.42
Weight, mean (SD), kg	64.4 (8.5)	61 (7.03)	0.31
BMI, mean (SD),kg/m^2	24.5 (2.9)	23.4 (3.4)	0.40

The table 5.2 shows that there was no significant difference between male and female population in the steady with respect to baseline characteristics.

TABLE : 5.3: Duration for which each exercise was performed.

<table>
<tr><th>EXERCISE</th><th>DURATION
(in seconds)</th><th>p-value</th><th>p-value</th></tr>
<tr><td>1</td><td>75 (52, 84)</td><td rowspan="2">0.002</td><td rowspan="4">=0.07</td></tr>
<tr><td>2</td><td>94 (56, 120)</td></tr>
<tr><td>3</td><td>66 (51.3, 105.8)</td><td rowspan="2"><0.001</td></tr>
<tr><td>4</td><td>98 (63.8, 148.5)</td></tr>
</table>

The table 5.3 suggests that exercise 4 was performed for longer duration of time followed by exercise 2, exercise 3 and exercise 1 respectively. The p-value of 0.007 was established between all four exercise tests suggesting of weak significant difference between each. There was significant difference between exercise 1 and exercise 2 with p-value of 0.002; and between exercise 3 and exercise 4 with p-value of <0.001.

TABLE : 5.4: Difference in oxygen saturation within each exercise.

EXERCISE	SpO_2 (PRE) %	SpO_2 (POST) %	p-value
1	96(95.8, 97)	96 (93.5, 97)	=0.01*
2	97 (96,97)	96.5 (95.7, 98)	0.34
3	96 (95,97)	95 (92.8, 97)	<0.046*
4	96(95.8,97)	98.5 (96.8, 99)	0.001**

The Table 5.4 shows that, there was significant change in oxygen saturation pre and post exercise capacity test within exercise 1, exercise 3 and exercise 4.

TABLE : 5.5: Difference in heart rate (HR) within each exercise.

EXERCISE	HR (PRE) (bpm)	HR (POST) (bpm)	p-value
1	79.5 (73,97)	95.5 (86.5, 100.5)	0.004**
2	79.5 (77, 86.8)	92 (82,102.5)	0.003**
3	83 (72,89)	99 (92, 106.5)	<0.001**
4	83 (75.8, 87.3)	99.5 (84.3, 110.5)	<0.001**

The table 5.5 shows that, there was significant rise in heart rate in all four exercises post exercise capacity testing.

TABLE : 5.6: Difference in Borg's score within each exercise.

EXERCISE	BORG'S (PRE)	BORG'S (POST)	p-value
1	10 (9,11)	13 (12.8,14)	<0.001**
2	9.5 (8.7,12)	13 (12.7, 14)	<0.001**
3	10 (9,12)	14 (12.8, 14.3)	<0.001**
4	10 (9,12)	14 (12,15)	=0.001**

The table 5.6 shows that, there was significant rise in the Borg's score within all four exercise post exercise testing.

TABLE : 5.7: Difference in Recovery (1=subjective; 2=objective) witnin group

EXERCISE	RECOVERY 1 (second)	RECOVERY 2 (second)	p-value
1	50.5 (36.8, 59.3)	71 (59,123.5)	<0.001**
2	30 (20,56)	66.5 (42.7, 102.25)	<0.001**
3	36 (30.8, 55)	78.5 (49.8, 150.3)	<0.001**
4	37 (24.5, 59.3)	86 (54.5, 120)	=0.001**

The table 5.7 conclude that, there was significant difference between recovery 1 (subjective) and recovery 2 (objective) within all 4 exercise post exercise capacity testing.

TABLE : 5.8: Data for outcome measures for all four exercise at baseline.

EXERCISE / OUTCOME MEASURES	1	2	3	4	p-value
SpO2 (median) % IQR	96 (95.8, 97)	97 (96,97)	96 (95,97)	96 (95.8,97)	0.53
Borg’s Score (median) IQR	10 (9, 11)	9.5 (8.7, 12)	10 (9, 12)	9.5 (9, 12)	0.54
Heart rate (median) bpm IQR	79.5 (73,97)	79.5 (77,86.8)	83 (77,89)	83 (75.8, 87.3)	0.95

The table 5.8 shows that, there was no significant difference between each exercise at baseline with respect to Spo_2, Borg’s score and Heart rate.

TABLE : 5.9: Data for outcome measures for all four exercise post exercise testing.

EXERCISE / OUTCOME MEASURES	1	2	3	4	p-value
SpO2 (median) % IQR	96 (93.5, 97)	96.5 (95.7, 98)	95 (92.8,97)	98.5 (96.8, 99)	<0.001**
Borg's Score (median) IQR	13 (12.8, 14)	13 (12.75, 14)	14 (92.109.5)	14 (12,15)	0.70
Heart rate (median)bpm IQR	95.5 (86.5, 100.5)	92 (82, 102.5)	99 (92.109.5)	99.5 (84.3, 110.5)	0.31
Recovery 1 (median) IQR	50.5 (36.8, 59.3)	30 (20,56)	36 (30.8, 55)	37 (24.5, 59.3)	0.19
Recovery 2 (median) IQR	71 (59, 123.5)	66.5 (42.7,102.3)	78.5 (49.8,150.3)	86 (54.5, 120)	0.51

The table 5.9 states that, there was significant difference between all four exercises in SpO_2 post exercise testing.

DISCUSSION

The main finding of this study is that the patient with COPD are better able to perform for longer duration with inverted breathing pattern (expiration during concentric phase of UL movement) when compared with the results of frequently applied in exercise clinical practice (inspiration during concentric phase of UL movement). In addition, among the studied exercises, exercise 4 (task 4) shows significant increase in SpO_2 post exercise with prolonged recovery 2 (objective) period for the same exercise suggesting that the gain in SpO2 was maintained for longer time as compare to other exercise.

In 2007, Rabe et al observed that COPD could be the third most common cause of death worldwide by 2020.(33)In 2000, Donner and Bjermer observed that "although COPD is a major disease worldwide there is a perplexing current uncertainty about the nature of this disease" and that "COPD begins as a local inflammation in the lungs, and through differentiated pathways still to be clarified, this leads to systemic consequences”. (34)

In this direction, some studies have also related that although COPD is a respiratory disease affecting the lungs, it is known that its effects are not exclusively limited to the respiratory system, Consequently, there are non respiratory manifestations including skeletal muscle dysfunction with atrophy and weakness, systemic inflammation, nutritional depletion and malnutrition, which can contribute to exercise imitation and affect patients’ function and mobility.(20,35-38)In their study, Papaioannou et al. observed that higher systemic levels of oxidative stress in COPD patients may contribute to a reduction in the body mass and fat-free mass indexes, thereby contributing to impaired exercise capacity.(39)

From this aspect, studies have shown that in COPD patients, the peripheral muscles are frequently affected, involving respiratory as well as upper and lower limbs muscles. According to Levine et al. [40]and Gosker et al.[41] patients with COPD a higher present ratio of type I fibers in the diaphragm muscle and this process can contribute to the reduction in force generation. In contrast, peripheral muscles dysfunction is characterized by a reduction in the percentage of oxidative fibers (type in relation to glycolytic fibers, thus contributing to reduction in the oxidative capacity of these muscles.[42,43] Due to dysfunction and atrophy in the striated skeletal muscles, COPD patients may show reduced exercise capacity in addition to impaired quality of life and an increased mortality rate.[44,45]

Tasks involving upper limbs vary considerably. They commonly involve lifting the upper limbs forward a movement that is both unsupported and dynamic. As a corollary, activities such as combing hair, brushing teeth or shaving involve UL movements and shoulder muscles without support i', in which the accessory muscles of inspiration assist the positioning of the trunk and upper limbs. This activities contributes to increased demand on these muscles and diaphragm overload, resulting in inspiratory movements with thoraco abdominal asynchrony and the premature appearance of dyspnea and leg fatigue, limiting the endurance of the upper limbs "According to Casaburi and Petty, the low tolerance of COPD patients during UL exercises is due to the fact that the shoulder and thorax muscles participate in the respiratory processes and shoulder movements. [46]

In clinical practice, UL exercises can be performed with and without support. Among those without support are the exercises used in this study, specifically shoulder flexion and horizontal abduction-adduction, which can be associated with the respiratory pattern, considering expiration during concentric phase of the movements.

Very few studies related to different respiratory pattern has been conducted. In 2011, Dirceu C et al. studied respiratory pattern of COPD patients during different UL exercises associated with respiratory exercises, and showed that in exercises performed with inverted respiratory time there was no increase in thoraco-abdominal asynchrony when compared with the rest condition and other exercise. (16) However, there are no studies relating respiratory pattern and upper limb exercise capacity during the different respiratory patterns associated with these exercises performed with inverted movements by patients with COPD

Hussain et al. reported that the ribcage muscles are recruited for multiple activities, such as breathing, postural support, and stabilization during the tasks performed with UL and their positioning. (47) When there is an increase in ventilatory necessity, such as in physical exercise, the accessory and expiratory muscles are recruited. When the coordination of these muscles with the primary motor muscles of inspiration is altered, it can cause airway obstruction, thoracic wall distortion and inefficient muscle actions, and all these alterations cause disadvantage in respiratory work. (15)

Celli et al. also studied the ventilatory and metabolic responses during UL exercises without support in COPD patients and showed that this exercise promoted thoraco-abdominal asynchrony, followed by dyspnea.(15) In 1992,Couser et al. observed that arm elevation in normal subjects promoted an increase in ventilatory and metabolic demands similar to mild exercise with changes in ribcage and or abdominal mechanics. (48) This can help to explain the limitation in exercise tolerance observed in unsupported UL activities in these subjects and this could be more relevant in COPD patients whose diaphragm muscles are less effective.

In our study, exercise 2 and exercise 4, in which the respiratory movement was inverted, were able to perform for longer duration of time when compared to exercise 1 and exercise 3 with p value of 0.002 and p value 40.001 respectively. A possible explanation for this is that during inspiration, when the UL are turned down (as in exercise 2), it decreases the double action of accessory muscles: differently from exercise and exercise 3. in which the accessory muscles assist the UL during the rising movement. This decreases work load on accessory muscles thereby delaying fatigue to set in.

Significant rise in SpO_2 during exercise 4 could be the result of intensification of breathing that was being achieved only by the muscles responsible for the action, w interference by the accessory muscles in the movement, probably without overloading th diaphragm. Although the exercise 4 has shown rise in SpO_2 excrcise 2 showed slight fall in SpO_2 which was not significant when compared to exercise 1 and exercise 3 where the fall in spos was significant. In exercise 1 and exercise 3. the decrease in SpO_2 can be explained by the combined movement of shoulder flexion, shoulder abduction and assistance with breathing, while in exercise 2 and exercise 4. the inversion of breathing helped to inhibit the accessory muscles of respiration, restricting them to only their main action during the shoulder exercise.

During exercises 3 and 4. it is important to emphasize the inversion of respiratory movements associated with the intense use of accessory muscles of respiration related to the ribcage expansion movement. In the horizontal abduction movement with inspiration, the muscles assist in inspiration and also in ribcage expansion, in this context, operating in the two functions, while during the horizontal adduction with inspiration, the ribcage expansion is more restricted, which could minimize action of the accessory muscles as well as hyperinflation associated with upper limb exercise in these patients. This could explain why there was improvement in upper limb exercise capacity in this type of exercise, with the reduced function of the accessory muscles of respiration. Some muscles of the superior part of the thorax and scapular girdle, which serve for respiratory and postural functions, have thoracic and extra thoracic attachment points, such as the inferior/superior trapezius latissimus dorsi, serratus anterior, subclavius and pectoralis major and minor. In COPD patients with pulmonary hyperinflation, which frequently occurs, the diaphragm lowers and loses its capacity to generate force, so that the ribcage muscles become more important to generate the inspiratory pressures. in this sense, and based on the results of the present study, it is suggested that exercises that minimize the action of accessory muscles of inspiration are more appropriate for COPD patients, because they direct the inspiratory movement to the muscles suitable for the movement, especially the diaphragm muscle.

Limitations of the study:

- Small sample size
- Lack of sophisticated assessment tools for assessing exercise capacity of upper limb.
- scarcity of studies about the issue and methodology used.

Future recommendations:

- Longitudinal studies should be done to find the prolonged effects of inverted respiratory patterns in COPD as well as in healthy population.
- Future studies could relate this strategy to the breathing retraining during upper limb

CONCLUSION

The exercises performed with inverted respiratory time (exercise 2 and exercise 4) were able to perform better than other exercise (exercise l and exercise 3).

In addition, among the studied exercises, exercise 4 (task 4) shows significant increase in SpO_2 post exercise with prolonged recovery 2 (objective) period for the same exercise suggesting that the gain in SpO_2 was maintained for longer time as compare to other exercise.

SUMMARY

Globally, COPD has emerged as the major cause of morbidity and mortality expected to become the 3rd most leading cause of death and 5th leading cause of loss of 'Disability Adjusted Life Years' as per projection of the global burden of disease study.

Patients with COPD have reduced arm exercise capacity and frequently experienced marked dyspnea and fatigue during the performance of arm tasks important for daily living.

The present study aimed to compare different respiratory patterns on upper limb exercise capacity in patients with COPD

Twenty two COPD patients were recruited in the study from various hospital and old age homes across Mangalore. Upper limb exercise capacity was measured in all four types of exercises two shoulder flexion-extension (one associated with inspiratory time during the concentric phase and the other associated with expiratory time) and two shoulder abduction-adduction (same timing as above). SpO2, Borg's score and heart rate was noted pre and post UL exercise testing. Recovery both subjective and objective was noted post exercise testing.

The study concluded that the exercises performed with inverted were able to perform better than other exercise and can be used as important strategies during physical exercise programs in these patients.

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ANNEXURE

ANNEXURE-I

INFORMED CONSENT FORM

TITLE:

INVESTIGATOR: _ _ _ _ _ _ _ _ _ _ _ _

PURPOSE OF THE STUDY:

I_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ ,have been informed that this study will work towards improving Pulmonary function in male sedentary workers.

PROCEDURE:

Each term of the study protocol has been explained to me in detail. I understand that during the procedure, I will be receiving the treatment for one time a day. I understand that I will have to take this treatment for four weeks.

I understand that this will be done under investigator, _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ supervision. I am aware also that I have to follow therapists instructions as has been told to me.

CONFIDENTIALITY:

I understand that medical information provided by this study will be confidential. If the data are used for publication in the medical literature or for teaching purposes, no names will be used and other literature such as audio or video tapes will be used only with permission.

RISK AND DISCOMFORT: I understand that there are no potential risks associated with this procedure, and understand that investigator will accompany me during this procedure. There are no known hazards associated with this procedure

. **REFUSAL OR WITHDRAWL OF PARICIPATION:**

I understand that the decision my participation is wholly voluntary and I may refuse participate, may withdraw consent at any time during the study.

I also understand that the investigator may terminate my participation in the study at anytime after researcher has explained me the reasons to do so.

I _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ have explained to …………………………………. the purpose of the research, the procedures required and the possible risks and benefits, to the best of my ability.

…………………………………… ……………………………

Investigator Date

I ………………………………. Confirm that researcher has explained me the purpose of the research, the study procedure and the possible risks and benefits that I may experience. I have read and I have understood this consent to participate as a subject in this research project.

…………………….. …………………………

Subject Date

……………………….. ………………………….

Signature of the Witness

Date

ANNEXURE-1

ANNEXURE-2

ASSESSMENT FORM

Date:

Name:

Age: **Gender:**

Height (cm) : **Weight (kgs):**

BMI:

Smoking status:

Stage of COPD:

Oxygen saturation at the time of assessment:

Associated chronic conditions HTN (controlled uncontrolled)

DM (controlled uncontrolled)

Cardiovascular disorder

History of previous episode of exacerbation:

History of medications taken:

Any Musculoskeletal disorder:

History of Cerebrovascular disease: